Persistent Feature Extraction Using Topological Data Analysis

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Abstract: Topological data analysis (TDA) is emerging as one of the most general-purpose techniques for feature extraction in a variety of machine learning applications. It provides a scalable and robust way of computing meaningful features in noisy and high-dimensional datasets that are generically represented using simplicial or cubical complexes. This computation is done by first identifying the topological structures that encode the shape and connectedness information among the data points (samples), and then characterizing the structures based on their relative persistence over a wide range of spatial and/or temporal scales. In this talk, I will discuss successful demonstrations of this technique on two challenging computer vision problems, namely, multi-way classification of 3D meshes and textured images, and object recognition in unseen environments by an indoor ground robot. For both these problems, TDA yields a parsimonious set of features to explain the outcomes accurately with substantially less training effort as compared to state-of-the-art methods. I will conclude by pointing out future research directions.

Bio: Ashis G. Banerjee is an Associate Professor of Industrial & Systems Engineering and Mechanical Engineering at the University of Washington (UW). Prior to joining UW, he was a Research Scientist at GE Global Research and a Postdoctoral Associate at MIT. He obtained his Ph.D. and M.S. in Mechanical Engineering from the University of Maryland (UMD), College Park, and B.Tech. in Manufacturing Science and Engineering from IIT Kharagpur. Dr. Banerjee has published more than fifty five articles on a broad range of research topics spanning predictive analytics, AI-enabled robotics, and smart manufacturing. He has received several honors including the 2019 Amazon Research Award, 2012 Most Cited Paper Award from the Computer-Aided Design journal, and 2009 Best Mechanical Engineering Dissertation Award at UMD. He is an elected Senior Member of the IEEE, and serves on the Editorial Board of the IEEE Robotics and Automation Letters, ASME Journal of Mechanisms and Robotics, Frontiers in Robotics and AI, and Journal of Micro-Bio Robotics.